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(71) Applicant (*for all designated States except US*): CLEAR-DATA CORPORATION [US/US]; 5117 Sealands Lane, Fort Worth, TX 76116 (US).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): BOWERS, R., Kenneth [US/US]; 5117 Sealands Lane, Fort Worth, TX 76116 (US).

(74) Agents: ALBANESI, Todd, E. et al.; Crutsinger & Booth, 1601 Elm Street, Suite 1950, Dallas, TX 75201-4744 (US).

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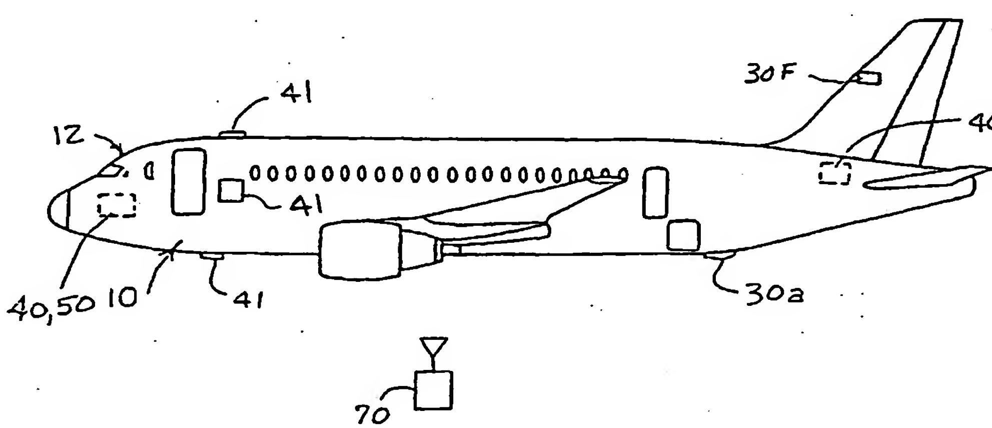

(57) **Abstract:** A wireless observation system for aircraft using a video apparatus (30a) mounted about the aircraft to capture images and transmitting the images to the cockpit (40) for use in observing those parts of the aircraft that cannot be seen from the cockpit. Transmission of the images is by use of radio frequency devices. The video apparatus is contained in an assembly (50) that includes remotely operable controls, which for example can be operated from the cockpit to alter the azimuth, elevation and focal length of the video apparatus. The output of the closed circuit television imaging apparatus can be transmitted to crash-proof recorder on board the aircraft, using the same radio frequency techniques. The video output of the closed circuit television apparatus may also be displayed on an in-flight entertainment system.

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WIRELESS AIRCRAFT DATA SYSTEM

Field of the Invention

The present inventions relate to remote onboard aircraft control and data feed back systems that use radio frequency signals as communication links within the aircraft. More specifically, the present inventions relate to the use of multiple sensors (in this case video sensors) to provide data (views of the aircraft's interior and exterior) to the cockpit and or alternatively to remote recorders. Two-way radio frequency transmissions of video data and video control signals are used. Radio frequency control signals are used to communicate with the remote video control mechanisms that alter the azimuth, elevation, zoom focal length light adjustments, etc. of the video devices.

Background

During abnormal or emergency conditions, a visual appraisal of the effected areas of an aircraft can provide valuable information to the pilot for use in evaluating possible corrective actions. On some prior large aircraft, a third cockpit crewmember was available to move about the aircraft to investigate. Visual appraisals from the aircraft are time consuming and ineffective in emergencies where time is critical. Even when time is not a factor, visual investigation from within the aircraft is worthless because there are critical areas of an aircraft that cannot be seen from the cockpit. In two crewmember cockpits, a crewmember is not always available to leave the cockpit for an inspection tour of the aircraft.

An example of a problem requiring external visual inspection is a condition known as "split flaps". This condition occurs when the high lift devices on one of the wing's trailing or leading edge do not respond as commanded and those on the other wing do. The effect of the flaps extended on one side of the aircraft and those on the

opposite side retracted is an uncommanded rolling motion. This rolling motion is not unique to the condition, but could be the result of a number of other factors.

Another challenge to evaluating an aircraft's condition is determining whether ice contamination of the wings and tail surfaces exists. These surfaces are not visible from the cockpit or in the case of the tail surfaces from anywhere inside the aircraft. Ice on the wings may be deduced from higher engine power requirements to maintain cruise flight, higher pitch attitudes to maintain level flight or generally sluggish performance of the aircraft. With the advent of jet powered aircraft flying at higher altitudes, the use of deicing equipment has been minimal. However, during climb out to a crusing altitude or descent for approach and landing, icing conditions may be unavoidable. The principal means of avoiding icing has been to climb or descend from conditions conducive to the formation of ice. However, if ice detection is delayed, the aircraft may not have the necessary performance to climb and a descent may be precluded by terrain or air traffic control radar coverage.

Certain ground operations require taxiing the aircraft close to objects. At present, the approved solution is to use ground personnel to act as "wing walkers" to show the cockpit crew that they have clearance from such objects. Using the reverse thrust capability of the engines to back an aircraft requires the use of "wing walkers."

During normal operations on the ground, the flight crew performs numerous checklists to prepare the aircraft for flight or shut down. In many cases, the crew must rely solely on the position of numerous status lights, switches and handles to perform these checks. A visual confirmation of the configuration of the aircraft is not possible from the cockpit. Military aircraft may rely on a "Runway Supervisor" to give an additional check of the configuration before take-off or landing. However, commercial and corporate aircraft, typically, do not have this safety advantage.

On board aircraft video systems could assist in solving these and other aircraft problems. Aircraft video systems have been proposed to provide video of the outside

of the aircraft. Examples include U.S. Patent Nos. 4,816,828, 5,574,497 and 5,440,337 and an Article published in the Royal Aeronautical Society's Aerospace International journal, March 1998, pages 28-31, entitled "Seeing a Safe Future."

The Royal Aeronautical Society's Aerospace International article suggests the desirability of using video cameras mounted in the cockpit to record the flight crew's actions and instrument readings and cameras recording the landing gear and the top of the fuselage and wings. It discusses multiplexing the various video signals for digital recording. The problems of mechanical and electrical installation are not addressed.

U.S. Patent No. 4,816,828 discloses an aircraft damage assessment and surveillance system that relies on a multitude of fixed video cameras mounted on the exterior of an aircraft. These cameras are connected to displays in the cockpit using hard-wired fiber optic or coaxial cable. The system includes recorders for use in recording the information from the cameras for later use during the accident investigations. In addition, it envisions a telemetry system transfer of captured optical images to ground based receiving stations. The system also includes a means of receiving video input from ground based cameras in order to view existing visibility conditions in the landing area prior to the approach to the runway. However, the necessity of the wiring associated with a multitude of cameras make the system undesirably heavy, add unnecessary fire hazards and is difficult to if not impossible to retrofit in many locations in the aircraft.

U.S. Patent Nos. 5,574,497 and 5,440,337 describe a system of cameras mounted on the exterior of an aircraft providing views of the terrain to the in-flight entertainment system. The systems also require multi-conductor on board electrical cable assemblies fabricated of twisted-shielded pairs, shielded singles, coaxial cable and unshielded single wires to connect the video cameras to the cabin of the aircraft. As such the systems of these patents suffer from the same disadvantages as the 4,816,828 patent's hard-wired system.

To be effective a video system requires mounting cameras at remote locations on the aircraft, with each camera directed toward a different part of the aircraft. Preferably, the cameras are versatile enough to provide variable focal length focusing and panning to increase the view range. Hard-wired systems require bulky power, data and control conductors. When retrofitting aircraft the difficulties associated with installing conductors between the cameras and cockpit makes hard-wired systems expensive. Further, these conductors provide fire hazards and add to the weight of the aircraft. Therefore, there is a need for wireless aircraft video systems for providing television cameras around or about the aircraft. As used herein, wireless means transferring (sending and/or receiving) data and control information without using hard-wired control conductors. Wireless transmissions include radio frequency, optical, acoustic and other media and forms for transferring information.

SUMMARY OF THE INVENTION

According to the present inventions a system of multiple remotely controllable data sensing devises are mounted at locations remote from the cockpit without the necessity of hard wiring with the cockpit. More particularly, the present inventions provide wireless transmission of video data (television pictures of the exterior and interior of an aircraft in flight and on the ground) from on-board video sensors to receivers located in the cockpit or at other remote locations. Wireless as used herein means without specially dedicated conductors for data. The systems of the present inventions are designed to be installed at remote locations on the aircraft and need only be connected to aircraft power available at the remote location. The system is wireless in the sense that there is no requirement for dedicated data conductors between the cockpit and cameras. According to the present inventions data and control functions are transmitted in duplex between the cockpit and camera by use of

radio frequency signals and can be installed on an aircraft without installing data and control cables between the cameras and cockpit.

It is also an object of the present invention to provide a device which is simple, lightweight and easy to install in both existing aircraft (retrofit) and aircraft in production. The use of a controlled, flexible mount to alter azimuth, elevation, focal length zoom and light settings of the camera allows for fewer cameras than a series of fixed view camera installations. This device is controlled by radio frequency transmitted commands sent wirelessly from the cockpit.

Another object is to provide onboard cameras with adjustable fields of view. The cameras are controllable from the cockpit and can be used in supporting ground operations by training the camera to look directly forward or aft and show the area into which the aircraft is taxiing or backing. This is particularly useful from the wingtip-mounted cameras in that it will show the exact clearance between the aircraft and other objects. The use of the zoom and directional control features allows the crew to focus with great fidelity on specific parts of the aircraft for a detailed examination. The controller in the cockpit will have several preset positions to which the cameras can be automatically commanded. These include the two forward wing cameras that can be trained directly forward, parallel to the longitudinal axis of the aircraft to aid in taxiing. The two aft wing mounted cameras can be trained directly aft, parallel to the longitudinal axis of the aircraft to aid in backing. These signals may be duplexed for the cockpit display in order to show the output of both cameras simultaneously on the same screen. A second receiver will be required in this case.

Another object is to provide video data for recording in a crash-proof storage medium for use by accident investigation authorities. Preferably, the transmission of the television picture is by the use of wireless transmitters for example radio frequency transmitters and receivers. The present invention may also use non-crash-proof

proof recording devices for the recording of engineering flight test data or some other commercial purpose.

A further object is to allow the output of one or more of the cameras to be displayed in the in-flight entertainment system for the amusement and edification of the passengers.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and features of the present inventions will be described by reference to accompanying drawings of an example embodiment of the present inventions in which:

Fig. 1 is a side elevation view of an aircraft having a wireless air vehicle observation system according to the present inventions;

Fig. 2 is a plan view of the aircraft of Fig. 1;

Fig. 3 is a block diagram of the onboard components of one embodiment of the present invention;

Fig. 4 is a block diagram of the wireless azimuth, elevation and zoom camera control component of the present invention;

Fig. 5 is a front elevation view illustration of an embodiment of the camera assembly of the present invention;

Fig. 6 is a right side elevation view illustration of an embodiment of the camera assembly of the present invention; and

Fig. 7 is a plan view illustrating of an embodiment of the camera assembly of the present invention.

DETAILED DESCRIPTION AND PREFERRED EMBODIMENT

Referring now to the accompanying drawings wherein like reference characters are used to designate like or corresponding parts throughout the various figures, there is shown in Figures 1 and 2 a conventional aircraft 10 with a wireless video observa-

tion system 12 in accordance with the present inventions. The aircraft 10 has conventional aircraft power network of circuits (not shown) installed throughout its cockpit's wings, tail, and fuselage for operating systems on board the aircraft. For purposes of description, system 12 is shown on a conventional multi engine commercial fixed wing aircraft and uses multiple cameras. The system 12 is wireless in the sense that it only requires connection to the existing aircraft power circuits and no specially dedicated data or control wiring need be installed. It should be understood that the present inventions have applications in all types of aircraft – commercial, private, military and even those requiring only one remote camera. In the illustrated embodiment system 12 comprises multiple video camera assemblies 30, radio frequency video receiver and display assemblies 40, and radio frequency video controller transmitter assemblies 50. Receiver and controller assemblies can be located in the cockpit 14 for use by the crew. A receiver 40 can be mounted remote of the cockpit in for example the tail section 14 and can be connected to a radio frequency video receiver and data recorder assembly 60 for storage of the video data for later use and analysis. The system of the present invention also contemplates the use of portable self-contained video receiver-controller assemblies 70 for use on board the aircraft or by ground crew. Radio frequency type transmitters and receivers were preferred because of costs and availability, but it is understood that other types of wireless systems could be used.

Camera assemblies 30 are spaced about the aircraft to provide selected views of the aircraft. Each camera assembly is designed to be self-contained in that it is not hard-wired back to the cockpit through data cables. Each camera assembly is designed to connect to local aircraft power circuits present throughout the aircraft. As will be described in detail each camera assembly includes a transmitter and receiver pair for transmitting video data to a video receiver assembly 40 and for receiving controlling data from radio frequency video controller transmitter assembly 50.

In the illustrated embodiment, system 12 includes several television camera assemblies positioned about the aircraft. The cameras are mounted to have critical areas of the aircraft within their field of view. In Figures 1 and 2 some possible external critical camera locations are illustrated. It is to be understood that more or less cameras could be used depending upon the vehicle and that cameras could be located inside the vehicle for example in the hold, cargo, or personnel areas for monitoring.

The landing gear and wing mounted engines are viewed by a camera contained in camera assembly 30a. Video data from this camera is transmitted to cockpit video receiver 40. Camera assembly 30a receives its control signals from the cockpit video controller transmitter assemblies 50 and adjusts the azimuth, elevation and focal length of this camera. This configuration allows the cockpit crew to see the position and condition of the landing gear and the wing mounted engines, as well as the underside of the aircraft.

The starboard side of the aircraft, 10, is monitored by cameras in assemblies 30b and 30c. Camera assembly 30b monitors the forward fuselage and wing leading edges. This provides direct visual observation of cargo hatches, equipment panels and the high lift devices on the wing leading edges. The condition of the leading edge is visible for scrutiny for contamination by ice. The ability to adjust the focal length of the camera will allow accurate appraisals of the leading edge condition.

Camera 30c monitors the aft fuselage, wing trailing edges, fuselage mounted engines and the tailplane. The aft fuselage cargo hatches, airstairs, ailerons, flaps, horizontal stabilizers, elevators, vertical stabilizers, rudders and the condition of aft mounted engines for structural integrity, smoke emission, fire and overheat conditions can be monitored with camera assembly 30c. Visual observations can be used to confirm instrument readings to ensure application of the proper procedures. There have been instances in which the flight crew agreed that an engine fire existed, but identified the wrong engine and it was inappropriately "shut down" leaving the afflicted aircraft with

a fire and reduced power. By a process similar to that described above, assemblies 30b and 39c send video data signals to cockpit receivers and receive control data from cockpit transmitters.

Camera assemblies 30d and 30e are mounted port side in locations corresponding respectively to the starboard camera assemblies 30b and 30c. The cameras in assemblies 30b-30e can be adjusted to center their field of view parallel to the longitudinal axis of the aircraft 10. This is of use during taxiing operations so that the cockpit crew can readily view the actual wing tip clearance when operating near objects.

Camera assembly 30f is mounted in the vertical stabilizer of aircraft 10 to give a plan-like view of the aircraft and quick view of the symmetry of the aircraft and its structural integrity.

In Figure 3, a block diagram of one embodiment of the system 12 is shown. As previously noted each camera assembly has a camera and transmitter for broadcasting video data through an antenna for receipt at a remote location on the aircraft such as the cockpit. Camera assembly 30a has a broadcast antenna 31a connected to the output of transmitter 32a. The output from video camera 33a is fed to transmitter 32a. Each of the camera assemblies are similarly configured. Transmitters 32 can transmit digital or analog data and can be am or fm modulated. Each transmitter is designed to be non-interfering (for example each using different frequencies) with the other transmitters so that video data can be transmitted from all camera assemblies simultaneously.

The transmissions from antennas 31 are received by video receiver assemblies 40 through one or more antennas 41 connected to cockpit receiver 42. The output of receiver 42 is then processed by the digital converter 43 and displayed in the cockpit on a standard cathode ray tube, 44. In addition, the output of cockpit receiver 42 may be displayed directly onto a monitoring device, 45. Although not shown, video receiver assembly

contains conventional switching mechanism to allow selection of video imaging for display on tube 44. By using the switching mechanism the operator can select which views to display as required.

The output of cockpit receiver 42 is also received by video recorder assembly 60 through antenna 61 and video receivers 62. Separate video receivers 62a-f can be provided tuned to receive the signals from each of the transmitters 30a-f. The output of video receivers 62 passes through a digital converter 63 to a crash-proof digital flight video recorder 64 in the aft of the aircraft 10. The flight video recorder has a recording channel for each camera input. It is certified to the same crash worthiness standards as the existing Cockpit Voice Recorder and Flight Data Recorder. It will retain the latest video input for up to thirty or forty-five minutes and match that data recorded by the Cockpit Voice Recorder and Flight Data Recorder. It is located in the aft section of the fuselage near these existing recorders. Electrical power will come from the existing wiring of the aircraft. It is also envisioned that self-contained portable video receiver assemblies 70 could receive through antenna 71 selected video from assemblies 30 for use by ground crew or as a mobile onboard receiver.

In Figure 4 a block diagram of the video controller transmission assemblies 50 is illustrated. Controller assemblies 50 provide control signals for adjusting the azimuth, elevation and focal length of the cameras in assemblies 30. Cockpit mounted controller assembly 50 has a controller 53 connected to individual transmitters 51a-51f tuned to transmit control signals to receivers 35a-f, respectively, mounted in the remote camera assemblies 30a-f. Antennas 52 for transmitters 51 can be mounted on the exterior of the aircraft in the cockpit area of the aircraft. Antennas 34 for each of the camera assembly receivers 35 can be separate antennas 34 or use antennas 31.

Transmitters 51 send signals from the controller 53 to the receivers 35. Receivers 35 are connected to actuators 36 for mechanically adjusting the azimuth, elevation and focal length of the cameras in assemblies 30. By using the controller

assemblies 50 the remote cameras can be panned and focused as required. In addition to the full range of motion control available to the crewmemer, the controller 53 has the capability to command the automatic positioning of the cameras to certain preset azimuth, elevation and zoom positions. In particular, cameras 30b and 30d can be automatically trained to a "taxiing" position such that they are pointed forward and parallel to the longitudinal axis of the aircraft. Cameras 30c and 30e can be automatically trained to a "backing" position such that they are pointed aft and parallel to the longitudinal axis of the aircraft. For optimal use by the crew a second radio frequency receiver and duplexer 46 is located in the cockpit so that the output of two cameras may be used simultaneously.

Figures 5, 6 and 7 are various views of one embodiment of the camera assembly 30. Camera assembly 30 is preferably enclosed in a sealed housing 82. In the illustrated embodiment the housing 82 is cylindrical and has an annular flange 84 for mounting the housing 82 in a circular opening 83 in the skin 86 of the aircraft. The shape of the cylindrical housing and annular flange allow the mounting orientation of the housing to be set merely by rotating the housing in the opening 83. Antenna 31 (and 34 if necessary) are mounted on the exposed exterior of housing 82. A power cable 87 extends from the housing and as previously described is connected to local aircraft power. No other connections or cables are required to install the self contained camera assembly 30. According to the present inventions, duplex radio frequency communication between the control camera assemblies and controllers can be transmitted through the aircraft power circuits by carrier current methods well known in the industry. Thus, the video and control signals can be transmitted either as wireless radio transmissions or wireless as modulated carrier current of appropriate frequency impressed on the power circuits of the aircraft.

The outer or exposed surface 88 of the housing 82 has a portion 90 protruding slightly from the skin 86. The portion 90 includes a transparent window 92. A conven-

tional variable focus video camera 33 is mounted within the housing 82 recessed below the window 92. A mirror 96 positioned at the window 92 reflects images to the lens of the camera and allows the camera to be recessed. The mirror size is selected to provide a wide field of view for the camera. By positioning the camera within the housing, a minimal projection above the aircraft skin surface exists and positioning the camera within the housing minimizes disturbance of the airflow over the skin.

Alternative embodiments of this camera, or video capture system, and the one on the opposite wing, could include a dome above the moveable camera/mirror assembly. This dome could be in a form of a truncated cone or a hemisphere, thus reducing the silhouette presented to the airstream. Under this dome, the entire assembly could be rotated to give a full picture of the aircraft side view. This method could use either a direct camera view or a reflected view from a mirror. The dome could be fixed, with the camera or camera/mirror assembly rotating beneath it, or, with the dome as an integral part of the turret assembly. The symmetrical nature of the dome would not cause any appreciable changes in the perturbation of the airflow around it.

A second alternative embodiment, in either embodiment cited above, would be the use a fixed camera and a moveable mirror that could rotate or tilt in order to provide the desired view. Such a mirror could be flat or curved in order to provide the necessary view of the aircraft.

Camera 94 is connected to or supported from a moveable actuator assembly 36. Actuator assembly 36 is powered to selectively pan and tilt the camera and in turn change the azimuth and elevation of the focal direction of the camera 33. Electrically powered assemblies for controlling camera direction are commercially available in video surveillance cameras. The range of movements of assembly 36 allows the camera to

scan the reflected image on the surface of mirror 96. The focal and directional control of the camera allows the camera selectively and focuses on a wide view of the aircraft.

Transmitter 32 is mounted in the housing 82 and is connected to camera 33 and antenna 31. Transmitter 32 receives video data from camera 94 and converts it to a signal, which is sent wirelessly through antenna 31 to remote wireless receivers. Also mounted within the housing 82 is camera assembly receiver 35. Receiver 35 is coupled to either antenna 31 or a separate antenna 34 mounted on the exterior of housing 82. Control signals for the camera 94 and actuator assembly 36 are sent wireless from the cockpit to receiver 35. Receiver 35 is connected to camera 94 and actuator assembly 36 and provides signals to control the focus and panning of camera 82.

The method and system of the present invention provides exterior views of the aircraft to the cockpit and flight crew of those areas of the aircraft which cannot be seen from the cockpit. It also allows for the recording of these views, using analog or digital means, for later review by accident or incident investigation authorities or engineering personnel. It is accomplished by the use of several cameras, black and white, color, low light level or infrared, in a flexible mounting, which can adjust the camera's azimuth, elevation and focal length. The camera output is transmitted to antennas near the cockpit for the use of the flight crew and to antennas near the tail for the recording devices by the use of radio frequency means, using amplitude modulation, frequency modulation or spread spectrum techniques. The camera output may be in the format of NTSC, PAL or SECAM. Receivers in the cockpit and tail convert the radio frequency signal for use in a display device, either hand-held or integral to the control panel, such as a cathode ray tube, in the cockpit and to the crash-proof recording device in the rail.

In addition, the flight crew may select which camera to view and adjust that camera's azimuth, elevation and focal length to a particular area of interest. The control of the camera's azimuth, elevation and focal length is done by sending the commands

from the cockpit using radio frequency means, using amplitude modulation, frequency modulation or spread spectrum techniques. The output of the cockpit and video receivers may be converted to a digital format, by a digital engine, for display and recording purposes, if analog transmission is used. A digital transmission would not require this digital engine.

The invention is of prime importance to flight safety, including ground operations. The ability to visually analyze any given part of the exterior of the aircraft greatly enhances the flight crew's situational awareness during normal, abnormal and emergency operations.

The embodiments shown and described above are only exemplary. Many details are often found in the art such as: wireless components such as transmitters, receivers and antenna and remote control components such as camera pan and focus actuators. Therefore many such details are neither shown nor descried. It is not claimed that all of the details, parts, elements, or steps described and shown were invented herein. Even though numerous characteristics and advantages of the present inventions have been set forth in the foregoing description, together with details of the structure and function of the inventions, the disclosure is illustrative only, and changes may be made in the detail, especially in matters of shape, size and arrangement of the parts within the principles of the inventions to the full extent indicated by the broad general meaning of the terms used in the attached claims. The restrictive description and drawings of the specific examples above are not present to point out what an infringement of this patent would be, but are to provide at least one explanation of how to make and use the inventions. The limits of the inventions and the bounds of the patent protection are measured by and defined in the following claims.

What is claimed is:

1. A system for surveillance of physical conditions at locations on an aircraft otherwise inaccessible by operators of said aircraft during operation of said aircraft comprising:

at least one video camera means for capturing optical images of at least a portion of said aircraft during operation of said aircraft and for generating video electrical signals indicative of said optical image;

modulator and transmitter means associated with each of said at least one camera means for receiving said video electrical signals generated by said camera means and for generating a radio frequency signal and modulating said radio frequency signal with said video electrical signal and transmitting said radio frequency signal so modulated;

at least one receiver means for receiving said modulated radio frequency signals and regenerating therefrom said video electrical signals; and

display means visually accessible to said aircraft operators for receiving said regenerated video signals and generating therefrom the optical images captured by said camera means.

2. The system of Claim 1 further comprising:

electrically operated control mechanisms for selectively changing the physical parameters of each of said at least one video camera in response to received control signals; and

a control signal generator and transmitter means accessible to said operators of said aircraft for converting physical inputs from said operators to control signals and transmitting said control signals to said control mechanism.

3. The system of Claim 1 wherein said at least one video camera means comprises a plurality of video camera means and said modulator-transmitter means associated therewith.

4. The system of Claim 2 wherein said at least one video camera means comprises a plurality of video camera means and wherein each said camera means has a modulator-transmitter means associated therewith.

5. The system of Claim 3 additionally comprising switching means associated with said display means and accessible to said aircraft operators for selecting from the said received video signals, the signals from which a desired optical image is generated.

6. The system of Claim 1 wherein said modulated radio frequency signals are transmitted from said transmitter means to said receiver means by wireless method.

7. The system of Claim 1 wherein said modulated radio frequency signals are transmitted from said transmitter means to said receiver means via the power circuits of said aircraft through carrier current methods.

8. The system of Claim 3 wherein said modulated radio frequency signals are transmitted from said transmitter means to said receiver means by wireless method.

9. The system of Claim 3 wherein said modulated radio frequency signals are transmitted from said transmitter means to said receiver means via the power circuits of said aircraft through carrier current methods.

10. The system of Claim 1 wherein said at least one receiver means includes a receiver means remote from said aircraft and said system further comprises a second display means associated with said receiver means remote from said aircraft receiving said regenerated video signals and generating therefrom the optical images captured by said camera means.

11. A system for surveillance of physical conditions at locations on an aircraft otherwise inaccessible by operators of said aircraft during operation of said aircraft comprising:

at least one video camera for capturing optical images of at least a portion of said aircraft during operation of said aircraft and for generating video electrical signals indicative of said optical image;

a modulator and transmitter associated with each of said at least one camera for receiving said video electrical signals generated by said camera and for generating a radio frequency signal and modulating said radio frequency signal with said video electrical signal and transmitting said radio frequency signal so modulated;

at least one receiver for receiving said modulated radio frequency signals and regenerating therefrom said video electrical signals; and

at least one display visually accessible to said aircraft operators for receiving said regenerated video signals and generating therefrom the optical images captured by said camera.

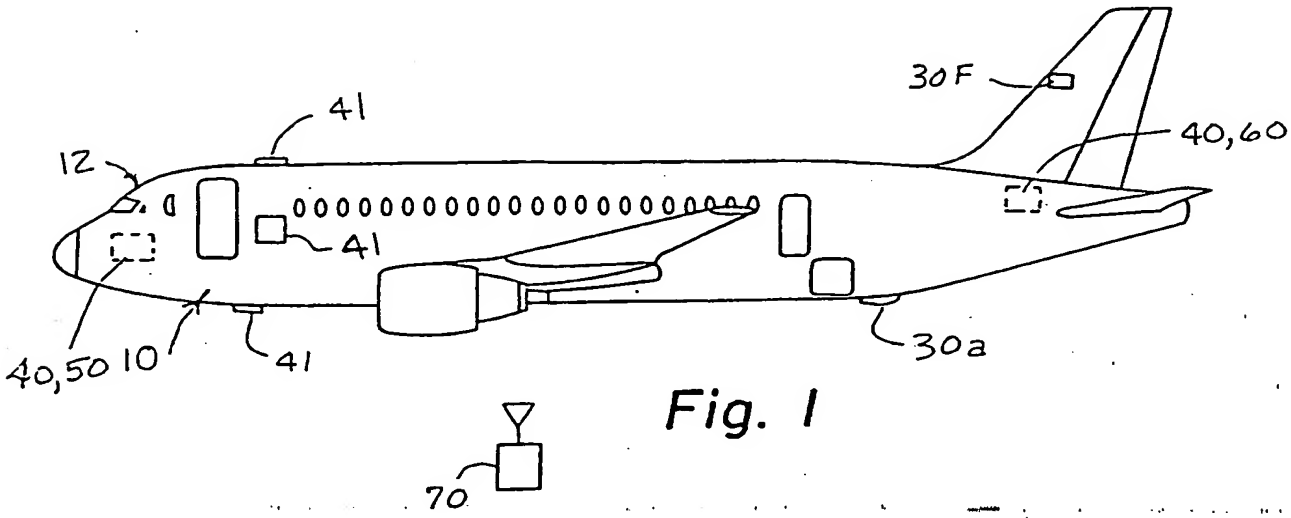

Fig. 1

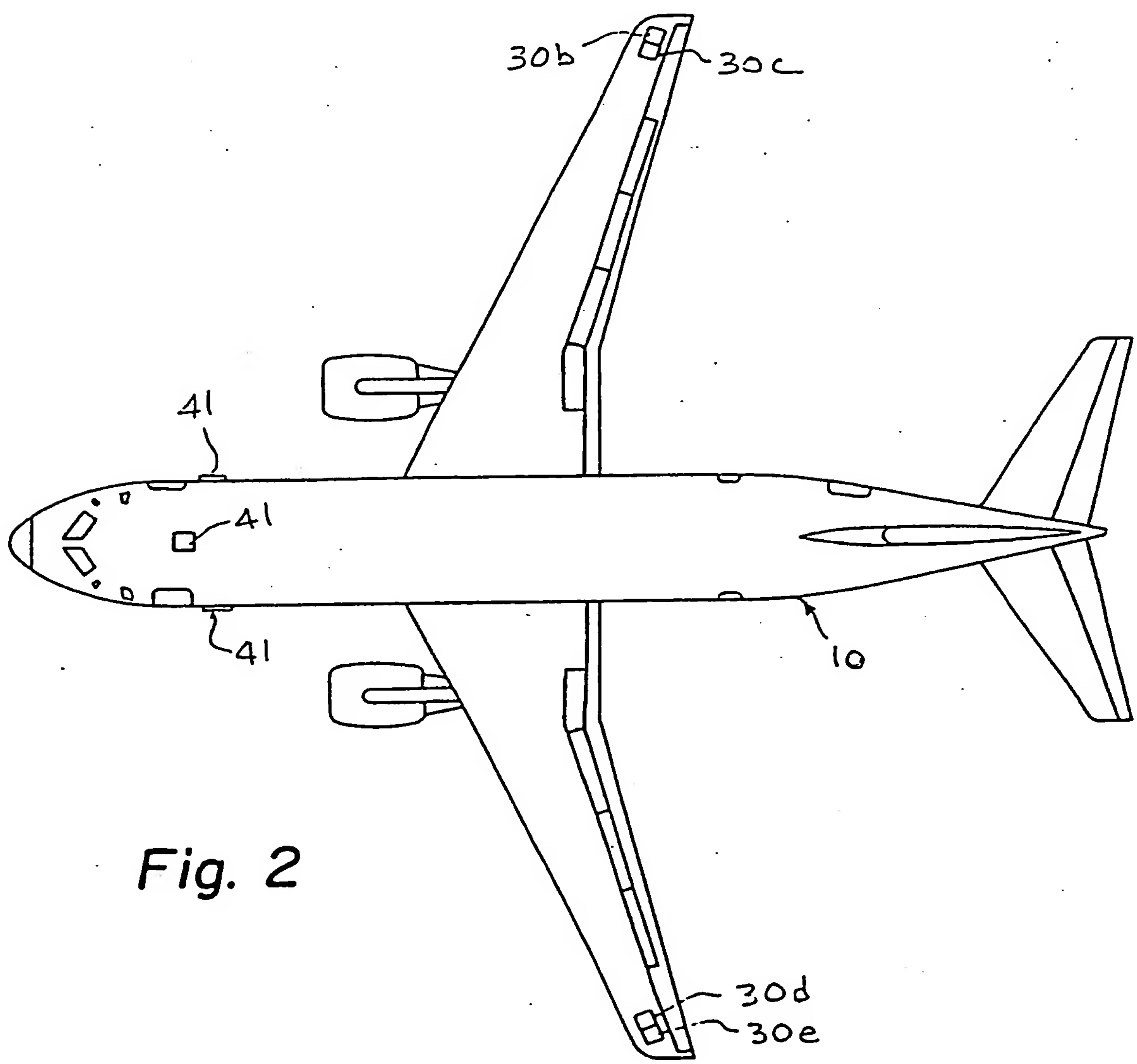

Fig. 2

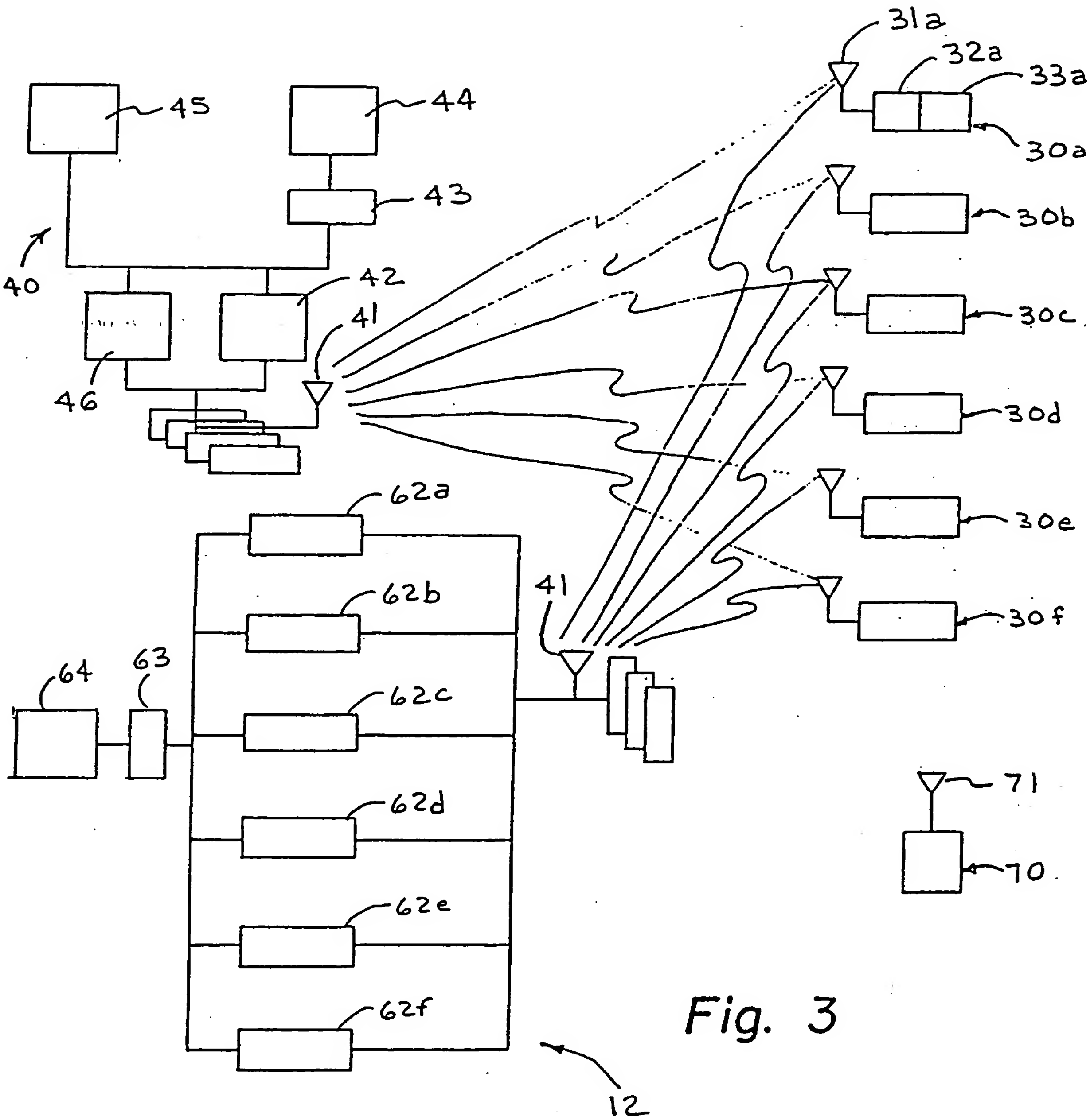
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Fig. 3

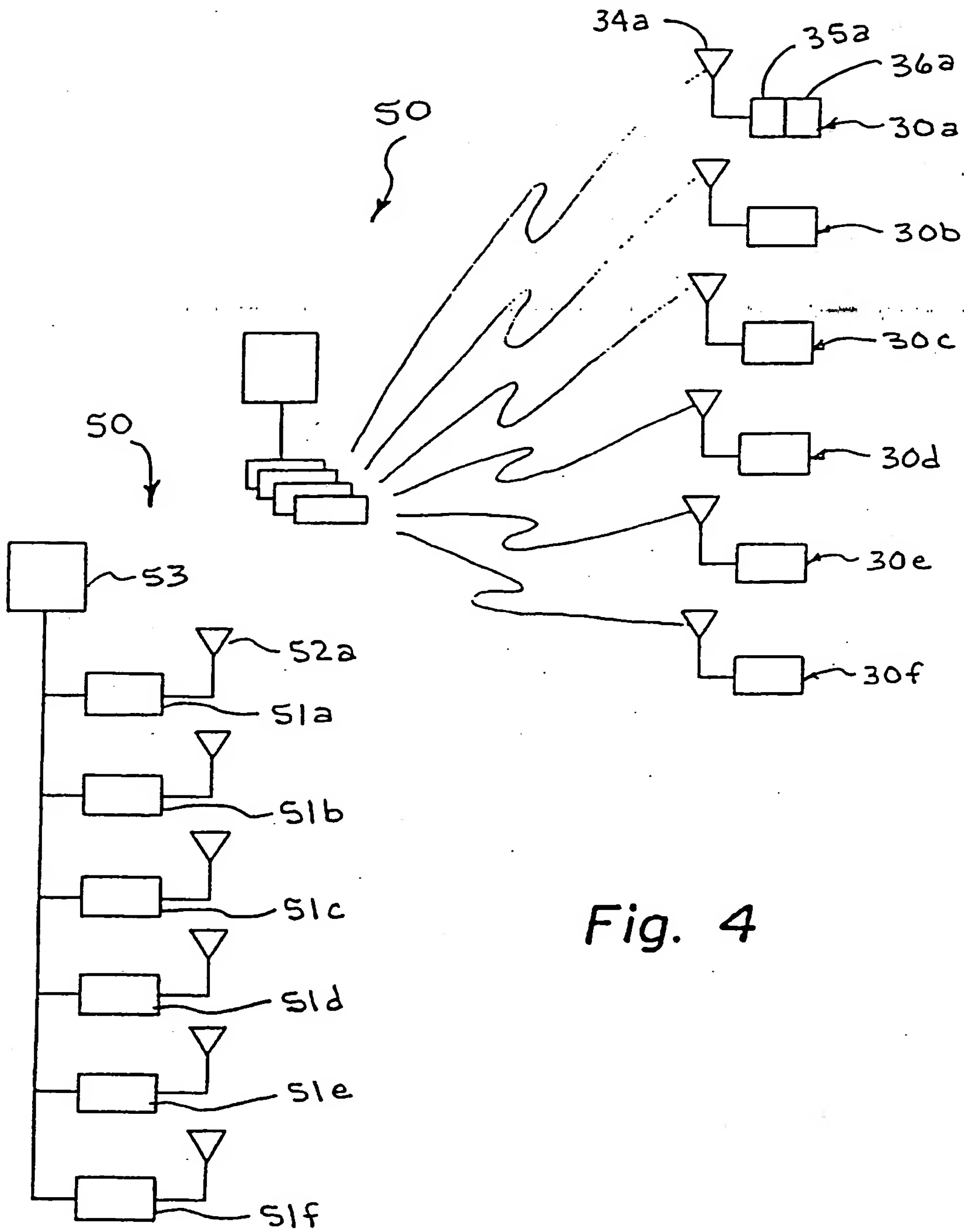
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Fig. 4

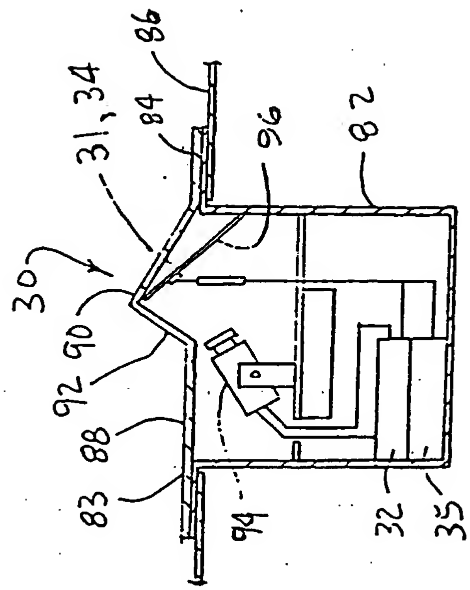

Fig. 6

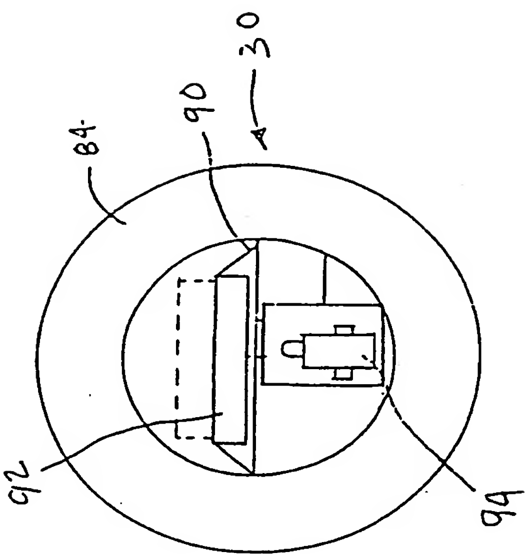

Fig. 7

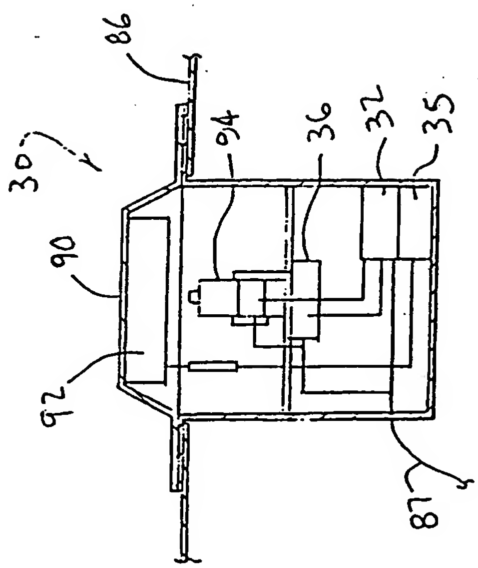

Fig. 5